भारतीय मानक
Indian Standard

IS 3521 (Part 1) : 2021

व्यक्तिगत फॉल एरेस्ट प्रणाली — विशिष्टि

भाग 1 पूरे शरीर का कवच

(चौथा पुनरीक्षण)

Personal Fall Arrest Systems — Specification

Part 1 Full Body Harness

(Fourth Revision)

ICS 13.340.99

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Occupational Safety and Health Sectional Committee, CHD 08

FOREWORD

This Indian Standard (Part 1) (Fourth Revision) is adopted by the Bureau of Indian Standards after the draft finalized by the Occupational Safety and Health Sectional Committee and approval of the Chemical Division Council.

Full body harnesses are required to protect persons from injury by arresting the fall in the event of the user losing his/her balance or support and falling from the place of working either at an elevation or in closed locations or containers. Some examples of work where a danger of fall exists are given below:

a) Industrial duty in plant and maintenance work while working at higher elevations;
b) Construction, erection, installation and such other jobs;
c) Working of electrical servicemen and linemen on general duty or high tension installation poles; installation and overhead maintenance and also for service to outdoor transformers and other similar jobs;
d) Workers working inside ship holds, tankers, silos, chimneys, manholes, sewers or similar other enclosed spaces;
e) Maintenance of buildings, structures or similar jobs, such as paintings, window cleaning, chimney cleaning, etc.; and
f) Working in potentially explosive environment.

This standard covers full body harnesses for use in safety installations. It does not cover anchorages, which are covered in IS 3521 (Part 7)/ISO 14567. It is emphasized that secured anchorage point should be located before using any type of full body harness.

In selecting suitable harness for a particular duty, care should be taken to ensure that such equipment gives the wearer protection, as far as possible, and also ensures safety, maximum degree of comfort, freedom of movement and in the event of falling, the greatest possible security against injury either from the impact from ground or from surrounding structures.

Such full body harnesses complying with this standard should satisfy ergonomic requirements and should only be used if the work allows means of anchorage and can be carried out safely. Personnel should be trained and instructed in the safe use of the equipment and be observant of such training and instruction.

IS 3521 was first published in 1965. The first, second and third revision were carried out in 1983, 1989 and 1999, respectively, in order to keep the standard up to date based on knowledge and practice at that time concerning the use of systems that incorporate a harness to restrain the body. In the third revision, the harness was classified on the basis of various positions of work; minimum width and thickness of the webbing for waist straps were specified and static and dynamic strength of the harness were also specified, for which test methods were also prescribed.

Fourth revision of the standard has been undertaken to harmonize the standard with the latest ISO standard, ISO 10333-1. The Committee decided not to adopt the ISO standard identically because there is additional content in the Indian Standard, hence this revision can be considered a technically modified adoption of ISO 10333-1. The major changes in this revision are:

a) IS 3521 split into several parts; this part deals with FBH;
b) Title harmonized with the title of ISO standard;
c) Terminology has been revised to include terms related to personal fall arrest system (PFAS);
d) Positioning of fall arrest attachment modified for Class A;
e) Positioning of work positioning attachment modified for Class P;
f) Concept of primary strap and secondary strap introduced, their width defined;
g) New test methods included: Buckle shake test, corrosion test, static suspension test and static suspension angle test; and
h) For performance test of harnesses, IS 3521 (Part 6)/ISO10333-6 has been referred.

(*Continued to third cover*)

Indian Standard

PERSONAL FALL ARREST SYSTEMS — SPECIFICATION

PART 1 FULL BODY HARNESS

(Fourth Revision)

1 SCOPE

1.1 This standard (Part 1) specifies the requirements, methods of sampling, test methods, instructions for general use, marking, packaging and maintenance for full-body harnesses (FBH).

The main purpose of a FBH is to allow the user to connect into a personal fall-arrest system (PFAS), which has been specified in IS 3521 (Part 6)/ISO 10333-6, such that if an arrest takes place, the arresting force will not exceed 6 kN.

1.2 For the purposes of this standard, FBH may have attachment elements that allow the user to connect into other types of safety or access system, for example a work-positioning system, a controlled descent/ascent system or a confined-space access system. This part of IS 3521 includes requirements for such attachment elements.

This part of IS 3521 is applicable only to FBH limited to single-person use of a total mass not exceeding 100 kg.

NOTE — Users of fall-protection equipment whose total mass (including tools and equipment) exceeds 100 kg are advised to seek advice from the equipment manufacturer regarding the suitability of the equipment, which may need additional testing.

1.3 The scope of this part does not extend to:

a) Waist belts or chest harnesses: such equipment is not considered as safe to use in personal fall-arrest systems (PFAS);
b) All other types of harnesses that are not designed primarily for use in PFAS;
c) Other special requirements for FBH, peculiar to use in a controlled descent/ascent system or a confined-space access system; and
d) Any assessment of compatibility or suitability in respect of the performance of FBH in a controlled descent/ascent system or a confined-space access system.

1.4 This part does not specify those additional requirements that would apply when harnesses are subjected to special conditions of use (where, for example, there exist unusual limitations concerning access to the place of work and/or particular environmental factors). Thus, treatments to ensure the durability of the materials of construction (such as heat treatment, anti-corrosion treatment, protection against physical and chemical hazards) are not specified in this part of IS 3521, but should comply with appropriate national standards and other specifications dealing with relevant physical characteristics and/or the safety of users. In particular, when it is considered necessary to test the corrosion resistance of metallic parts of the equipment, reference should be made to ISO 9227.

2 REFERENCES

The standards listed below contain provisions which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this Indian Standard are encouraged to investigate the possibility of applying the most recent editions of the Indian Standards indicated below:

IS No./ISO No.	*Title*
3521(Part 5) : 2021/ ISO 10333-5 : 2001	Personal fall-arrest systems: Part 5 Connectors
3521 (Part 6) : 2021/ ISO 10333-6 : 2004	Personal fall arrest systems — Specification: Part 6 System performance tests
101 (Part 3/Sec 2) : 1989	Methods of sampling and test for paints, varnishes and related products: Part 3 tests on paint film formation, Section 2 Film thickness (*third revision*)
3203 : 1982	Methods of testing local thickness of electroplated coatings (*first revision*)
ISO 9227 : 1990	Corrosion tests in artificial atmospheres — Salt spray tests

World Medical Association Recommendations Guiding Physicians in Biomedical Research Involving Human Subjects (Helsinki Declaration), adopted by the 18th World Medical Assembly, Helsinki, Finland, June 1964 and amended by the 29th World Medical Assembly, Tokyo, Japan, October 1975, 35th World Medical Assembly, Venice, Italy, October 1983, 41st World Medical Assembly, Hong Kong, September 1989 and the 48th General Assembly, Somerset West, Republic of South Africa, October 1996.

3 TERMINOLOGY

3.1 Full-body Harnesses

3.1.1 *Full-body Harness* (*FBH*) — Component of the body-holding device which connects a person into a personal fall-arrest system (*see* Fig. 1).

NOTES

1 The FBH may comprise straps, fittings, buckles or other elements suitably arranged and assembled to support the body of a person and to restrain the wearer during a fall and after the arrest of a fall.

2 The FBH may incorporate other fittings which permit its connection into other types of safety systems such as a work-positioning system.

3.1.2 *Primary Strap* — Strap of a full-body harness that is intended by the manufacturer to transmit load, and support the body or exert pressure on the body during a fall of the person and after the arrest of a fall.

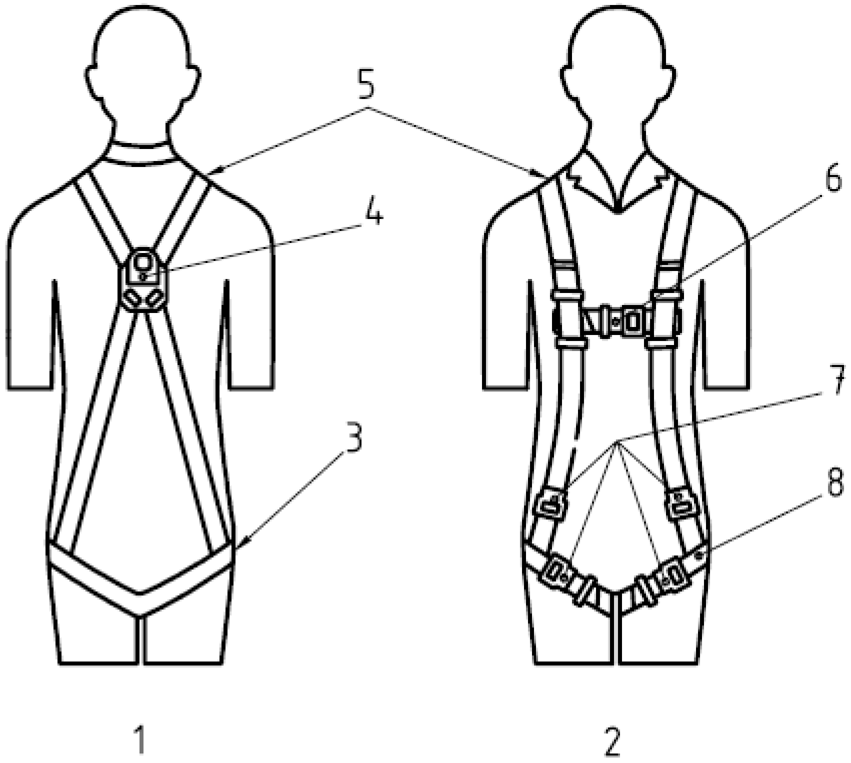
3.1.3 *Secondary Strap* — Strap from which the FBH is constructed, other than primary straps.

3.1.4 *Fastening Buckle* — Two-part fitting designed to facilitate the donning and doffing of a FBH.

NOTES

1 The two parts can be coupled and uncoupled; each part is incorporated into mating straps, and when coupled together forms a joint between the mating straps.

2 A fastening buckle can be an adjusting buckle.



Key

1	Back 5 Shoulder straps	5	Shoulder straps
2	Front 6 Shoulder strap restrainer	6	Shoulder strap restrainer
3	Sub-pelvic strap 7 Buckles	7	Buckles
4	Fall-arrest attachment	8	Thigh straps

Fig. 1 Example of a FBH

3.1.5 *Adjusting Buckle* — Fitting designed to facilitate the lengthening or shortening of FBH straps, to provide adjustment for different body sizes and shapes.

NOTE — An adjusting buckle can be a fastening buckle.

3.1.6 *Fall-arrest Attachment Element* — Mandatory fitting designated as the point of attachment for the connection into a fall-arrest system.

3.1.7 *Work-positioning Attachment Element* — Optional fitting exclusively designated as the point of attachment for the connection into a work-positioning system.

3.1.8 *Controlled Descent/Ascent Attachment Element* — Optional fitting exclusively designated as the point of attachment for the connection into a controlled descent/ascent system.

3.1.9 *Confined-space Access Attachment Element* — Optional fitting exclusively designated as the point of attachment for the connection into a confined-space access system.

3.1.10 *Collector Plate* — Slotted plate which allows individual straps to intersect one another, and to be held in this position without being joined.

NOTE — This also allows independent adjustment, i.e. one strap can be adjusted without affecting the other.

3.1.11 *Cleat* — Retainer which when fitted to straps is designed to gather excess strap length after the process of adjustment has taken place.

NOTE — This prevents the nuisance and danger of flapping straps interfering with the worker's task.

3.1.12 *Comfort Pad* — Extra support fitted to any of the primary straps, which in effect locally increases the strap's width and thickness.

NOTE — This reduces the pressure exerted on the body by the FBH when in normal or emergency use.

3.1.13 *Work-positioning Back Support* — Rigid or semi-rigid back support which can be incorporated into a FBH.

3.1.14 *Tool Loop* — Accessory, usually fitted integrally to the waist strap of a FBH used to attach tools temporarily to the harness while a person is working.

3.1.15 *Total Mass* — Sum of the user's mass plus all attached clothing and equipment (other personal protective equipment, work related tools etc.).

3.1.16 *Waist Belt* — Part of FBH which is fastened round the waist.

3.1.17 *Lanyard* — Finished length of flexible material, which in conjunction with an energy absorber is used as a connecting subsystem in PFAS.

3.2 Systems

3.2.1 *Personal Fall-arrest System (PFAS)* — System designed to arrest a fall from a height, to minimize the fall-arrest forces, to control the total fall distance in order to prevent collision with the ground or other obstacle, and to maintain the fallen person in a suitable post-fall attitude.

3.2.2 *Work-positioning System* — System that enables a person to work supported by personal protective equipment in tension in such a way that a fall is prevented.

3.2.3 *Controlled Descent System* — System whereby a worker can descend from one level to another, by rappelling (abseiling) or other method, whilst suspended in an appropriate harness.

3.2.4 *Confined-space Access System* — System used in a work situation where the worker has to enter into a narrow or confined space using a ladder or by being suspended in a harness, and where emergency evacuation can only be carried out with the worker in a near upright position.

4 REQUIREMENTS

4.1 General

To ensure that components assembled into a personal fall-arrest system perform correctly, it is recommended that they be tested in accordance with IS 3521 (Part 6)/ISO 10333-6.

FBH may have attachment elements that allow the user to connect into other types of safety or access system, for example a work-positioning system, a controlled descent/ascent system or a confined-space access system.

4.2 Classification

4.2.1 *Class Identification*

This part of IS 3521 establishes a classification system that specifies that the fall-arrest function be mandatory and other functions be optional as follows:

a) All FBH shall be at least Class A for fall-arrest purposes (*see* Fig. 2);
b) Where FBH have optional attachment elements they are classified as follows:
    1) Class D for controlled descent/ascent purposes (*see* Fig. 2);
    2) Class E for confined-space access purposes (*see* Fig. 2);
    3) Class L for fall-arrest purposes whilst ladder climbing (*see* Fig. 2); and
    4) Class P for work-positioning purposes (*see* Fig. 2).

NOTE — A FBH may be in more than one class.

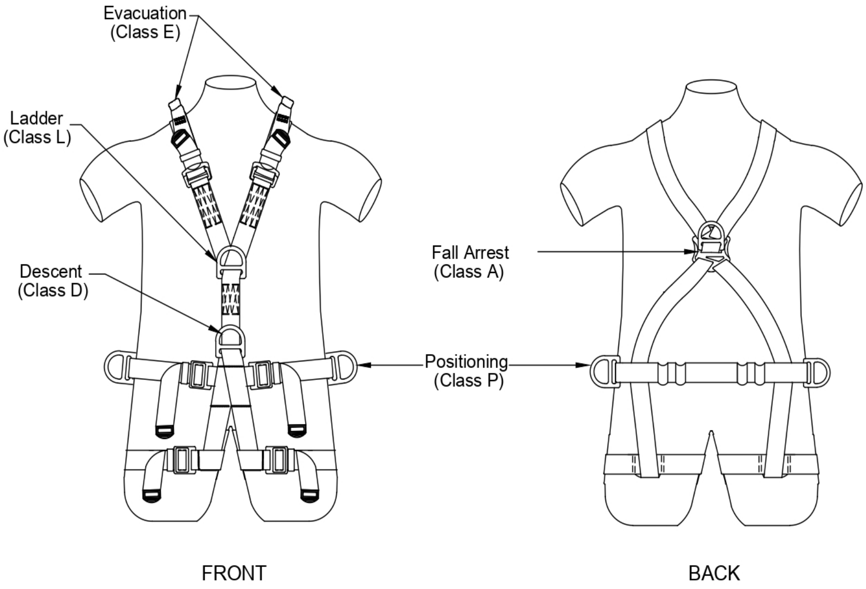


FIG. 2 FALL PROTECTION CLASSES

4.2.2 *Class A— Fall Arrest*

Class A FBH are designed to support the body during and after the arrest of a fall. They shall have at least one fall arrest attachment element, incorporated as to lie at the back of the wearer and centrally between the upper shoulder blades. The attachment element shall be easily reachable to user’s hands.

4.2.3 *Class D — Controlled Descent/Ascent*

Class D FBH are those which meet the requirements for Class A FBH and which have additional attachment elements that allow the user to connect into a controlled descent system. Class D FBH shall have the controlled descent/ascent attachment elements incorporated in such locations as to enable the user to adopt an approximate seated position whilst in suspension. Controlled descent/ascent attachment elements are not acceptable for connecting into a PFAS.

4.2.4 *Class E — Confined-space Access*

Class E FBH are those which meet the requirements for Class A FBH and which have additional attachment elements that allow the user to connect into a confined-space access system. Class E FBH shall have a sliding attachment element on each shoulder strap, to be used as a pair, that is, not separately, so as to enable the user to adopt a near upright position whilst in suspension. Confined-space access attachment elements are not acceptable for connecting into a PFAS.

4.2.5 *Class L — Fall Arrest (Ladder Climbing)*

Class L FBH are those which meet the requirements for Class A FBH, and which has an additional fall-arrest attachment element that allows the user to connect into a fall-arrest system necessary for use when climbing. They shall have at least one fall-arrest attachment element, incorporated as to lie at the front of the wearer and centrally between the rib cages.

4.2.6 *Class P — Work Positioning*

Class P FBH are those which meet the requirements for class A FBH and which have an additional attachment element or elements that allow the user to connect into a work-positioning system. Class P FBH shall have at least one work-positioning attachment element incorporated so as to lie at approximately waist level. If only one work positioning attachment element is provided, it shall lie centrally to the front. If work-positioning attachment elements are provided other than centrally at the front, they shall be placed symmetrically in pairs and shall only be used as a pair, i.e. not separately. Work-positioning attachment elements are not acceptable for connecting into a PFAS.

4.3 Design and Construction

4.3.1 *General Requirements*

4.3.1.1 The purpose of the FBH is to contain the body and to suitably distribute the dynamic fall-arrest forces and post fall-arrest suspension forces over the body. The FBH shall not create any supplementary risk and shall offer an acceptable degree of comfort.

4.3.1.2 A FBH shall comprise an assembly of joined straps, disposed around the pelvic area, legs and shoulders as shown in Fig. 1. In addition a waist belt strap and/or a chest strap may be incorporated. A means of adjustment shall be provided to enable the FBH to fit the wearer in accordance with the manufacturer's instructions.

4.3.1.3 The FBH shall be so designed so that when worn, the FBH straps shall be incapable of inadvertently migrating or loosening from their original position or setting.

4.3.1.4 A FBH may be incorporated within a garment.

4.3.1.5 It shall be possible to carry out a visual inspection of the whole FBH, even if incorporated within a garment.

4.3.1.6 A fall indicator identification shall be provided in the FBH.

4.3.2 *Textile Requirements*

4.3.2.1 Webbing and yarns shall be made from virgin filament, or from multi-filament synthetic fibres suitable for the use intended. The breaking strength of the synthetic fibre shall be at least 0.6N/tex^2. The Webbing Width will be 40 mm (min) and shall not break under a minimum tensile load of 19.6 kN (2 000 kg).

4.3.2.2 Primary straps shall have a width of at least 40 mm and secondary straps shall have a width of at least 20 mm. It shall be visually confirmed during the static suspension tests specified in **5.8** which of the straps that support the person are primary and which are secondary.

4.3.2.3 Sewing threads shall be physically compatible with and of a comparable quality to that of the webbing, but shall be of a different colour from that of the webbing in order to facilitate visual inspection. Number of stitches shall be not less than 3 per cm.

4.3.2.4 Webbing and rope shall pass the flammability tests as given in **5.10**.

4.3.3 *Requirements for Fittings*

4.3.3.1 All buckles, attachment elements, collector plates, cleats, comfort pads, back support pads and tool loops shall be smoothly finished and free from defects due to faulty material and manufacture; they shall not have sharp or rough edges that may cut, abrade or otherwise damage webbing or cause injury to the user.

4.3.3.2 All adjustment buckles shall self-lock securely onto the FBH webbing material but shall not present roughened surfaces or sharp edges that may abrade or otherwise damage the webbing material. Knurled bars are permitted.

4.3.3.3 Fastening buckles shall not be capable of inadvertent uncoupling.

4.3.4 *Additional Requirements for Attachment Elements*

4.3.4.1 All attachment elements made from loops of textile material shall be adequately protected against abrasion, both inside and outside of the loop.

4.3.4.2 Depending upon FBH classification, attachment elements shall be incorporated into the FBH so as to lie in the positions required in **4.2**. Under this part of IS 3521, front and side attachment elements for connecting into work positioning systems are not accepted for fall-arrest use.

4.3.4.3 The fall-arrest attachment element of a Class A FBH, incorporated as to lie at the back of the wearer and centrally between the upper shoulder blades, shall be so designed as to not slide down the back of the torso test mass during the inverted dynamic test described in **5.7.2**.

4.4 Corrosion Resistance

In order to protect all metal fittings against corrosion and/or other chemical reaction, it is necessary that all the fittings shall be coated by chromium plating or powder coating. The minimum thickness of chromium plating shall be 8 microns when measured in accordance with the method prescribed in IS 3203 whereas for powder coating the thickness shall be minimum 45 microns when measured in accordance with the method prescribed in IS 101 (Part 3/Set 2).

When tested in accordance with **5.2**, all metallic fittings shall be free of red rust, as visible to the unaided eye, or other evidence of corrosion of the base metal. Post-test presence of white scale is acceptable.

4.5 Buckle Uncoupling and Slippage

When tested in accordance with **5.3**, fastening buckles shall not uncouple, and adjustment buckles shall not allow a strap slippage of more than 25 mm.

4.6 Static Strength

4.6.1 The FBH shall withstand a force of 15 kN when tested:

a) At each fall-arrest attachment element as specified in **5.4**;
b) And where incorporated:
    1) At each controlled descent/ascent attachment element as specified in **5.5**;
    2) At each confined-space access attachment element as specified in **5.6**;
c) And shall show no:
    1) Tearing of webbing material;
    2) Complete separation of any sewn joint;
    3) Partial or complete fracture of any buckle; and
    4) Inadvertent opening of any fastening buckle.

4.6.2 Straps and attachment elements shall not asymmetrically migrate from position. Straps are allowed to slip through adjustment buckles, but not by more than 25 mm.

4.7 Dynamic Performance

4.7.1 The FBH shall retain the torso test mass clear of the ground and in an upright position when tested at each fall-arrest attachment element in accordance with **5.7.** In addition, there shall be:

a) No tearing of webbing material;

b) No tearing of any primary strap sewn joint;

c) No partial or complete fracture of any buckle; and

d) No inadvertent opening of any fastening buckle.

4.7.2 At the conclusion of the test the angle formed between the back of the torso test mass and the test lanyard shall not exceed 45°.

4.7.3 The FBH shall be capable of retaining the torso test mass in post-dynamic test suspension for a period of at least 10 min.

4.8 Static Suspension Test

The FBH shall retain the subject in a position with the head upright when tested at each fall-arrest attachment element in accordance with **5.8**. In addition, there shall be:

a) No metal fittings in contact with the groin, the inside of the thighs or the armpits;

b) No part of the FBH exerting direct pressure on the genitals, head or neck;

c) No intense pain felt; and

d) No restriction to normal breathing.

4.9 Static Suspension Angle Test for Class AE FBH

Class AE FBH shall retain the torso test mass in an upright position when tested at each confined-space access attachment element in accordance with **5.9**. The angle formed between the back of the torso test mass and the test lanyard shall not exceed 10°.

5 TEST METHODS

5.1 Apparatus

5.1.1 *Torso Test Mass for the Static Test* (*see* Fig. 3) — In accordance with the dimensions and requirements specified in Fig. 3. The suspension eyebolts should have an inside diameter of 40 mm and maximum cross-section diameter of 16 mm. The surface should be smooth and, if of timber construction, should be shellacked or varnished.

5.1.2 *Torso Test Mass for Dynamic Test* (*see* Fig. 4) — Constructed of rigid material with hard wood surfaces in contact with the FBH webbing straps as in Fig . 4a) and 4b) and shall have a mass of (100 ± 1) kg. The included angle between section line A in Fig. 4a) and the shoulder line shall be (22.5 ± 5)°.

5.1.3 *Test Lanyard* — Of wire rope terminated with snap hooks such that the combined length of wire and hooks is (2400 ± 25) mm, measured from snap hook to snap hook bearing points under a tension of 44 N. The lanyard shall be fabricated from type 302 stainless steel in a 9.5 mm diameter, 7 × 19 aircraft cable construction. The lanyard terminations shall be formed by a method which prevents cable slippage.

5.1.4 Test structure, consisting of the following:

a) The rigid anchorage structure shall be so constructed that its natural frequency of vibration in the vertical axis at the anchorage point is not less than 100 Hz and so that the application of a force of 20 kN on the anchorage point does not cause a deflection greater than 1 mm;

b) The rigid anchorage point should be a ring of (20 ± 1) mm bore and (15 ± 1) mm diameter cross-section, or a rod of the same diameter cross-section;

c) The rigid anchorage point shall be at such a height to prevent the torso test mass from striking the floor during dynamic testing.

5.1.5 *Static Strength Test Apparatus* — Consisting of a test frame, winch or hydraulic puller and indicator, with sufficient traverse to load the torso test mass.

5.1.6 *Quick-release Device* — Compatible with the eyebolt of the torso test mass or connectors which ensures the release of the test mass without initial velocity.

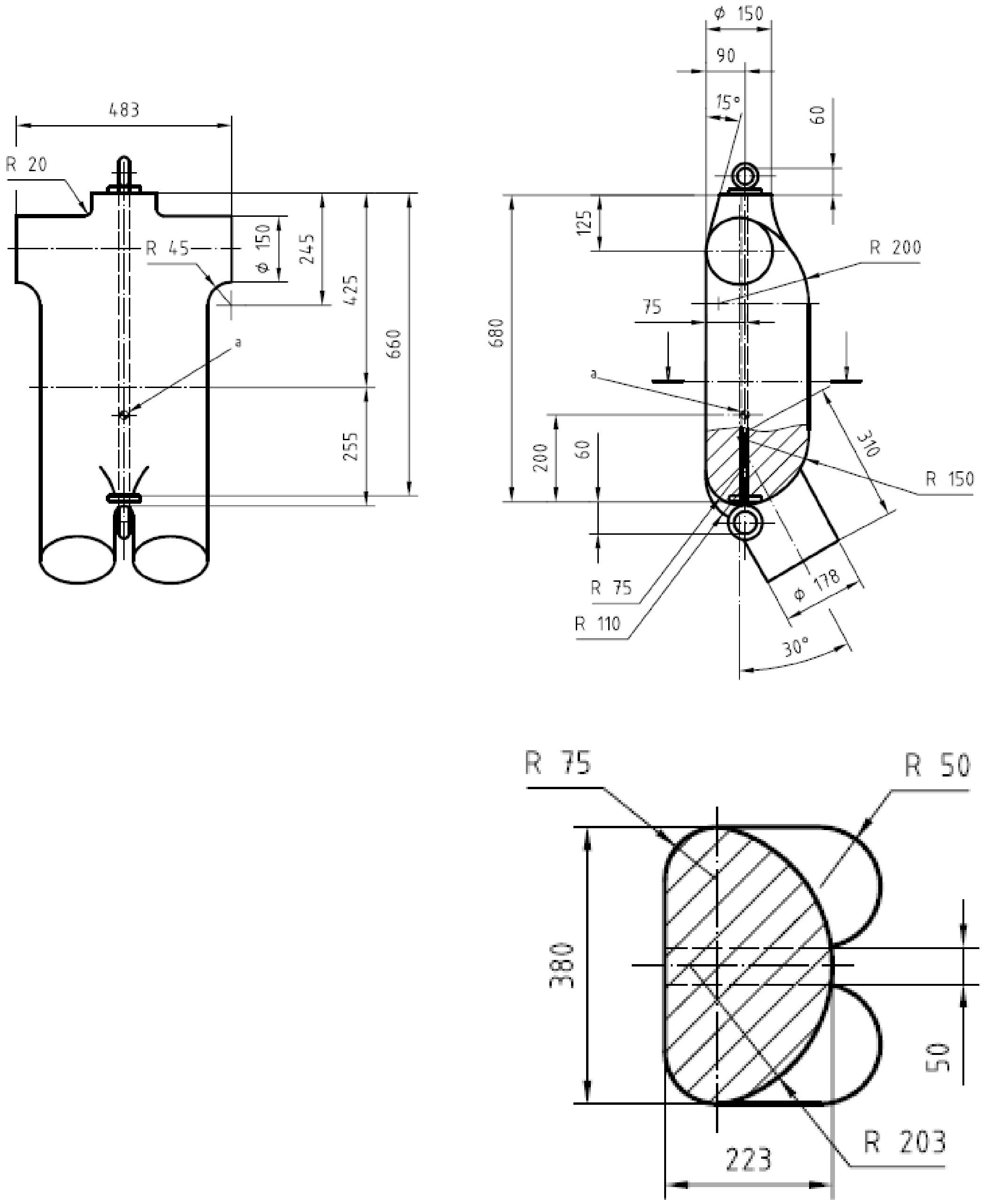
5.1.7 *Test Yoke* — Consisting of a bar 200 mm long with two connected ropes equal in length and at least 300 mm, constructed as shown in Figure 5. Each rope shall be terminated with a connector. An attachment point for test purposes shall be provided at the centre of the bar.

5.1.8 *Force-measuring Instrumentation* — Capable of measuring forces from 1.2 kN to 20 kN with an accuracy of ±2 percent and withstanding a force of 50 kN without damage, and arranged so that measurements are carried out with a continuously active band up to 100 Hz but with a minimum sampling rate of 1000 Hz.

5.2 Corrosion Test

The metallic fittings shall be salt spray tested in accordance with ISO 9227, with an initial exposure of 24 h, followed by 1 h of drying, followed by a second exposure of 24 h.

Dimensions in millimetres



Minimum radius of curvature: R 50

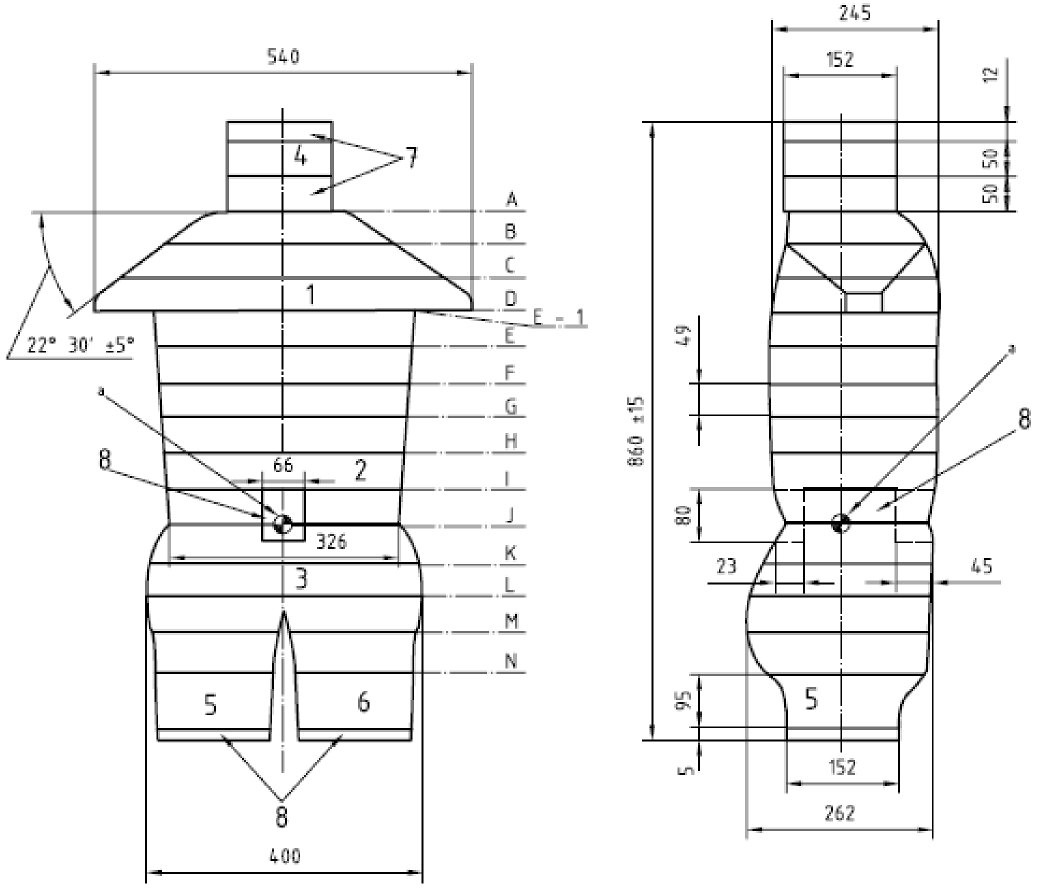
Mass: 100 kg

Material: hardwood or plastics (Shore hardness > 90)

a Centre of gravity

FIG. 3 TORSO TEST MASS FOR STATIC TESTING

Dimensions in millimetres



Materials:

Sections 1, 2 and 3: hard wood

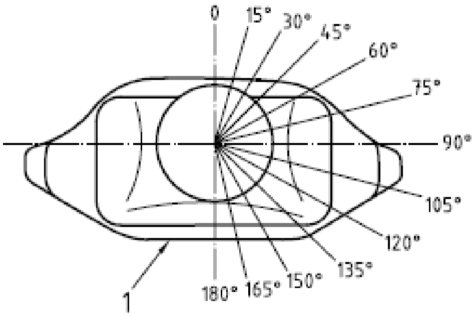
Sections 4, 5 and 6: lead

Sections 7 and 8: steel

NOTE Shapes are approximate.

a Centre of gravity

a) Horizontal Half-Sections of Torso Test Mass



Datum Level	Back 0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	Front 180°
A	72	71	77	83	87	85	84	82	86	85	81	78	77
B	70	72	78	96	135	166	160	165	182	164	134	119	114
C	92	95	106	130	164	188	245	243	200	182	157	142	138
D	104	107	117	130	153	178	235	273	213	181	162	144	138
E-1	105	106	108	117	131	153	175	176	160	148	141	139	138
E	104	105	108	117	131	153	175	174	159	146	140	138	138
F	104	105	108	116	130	152	173	174	163	149	142	139	138
G	102	103	106	114	128	149	170	174	162	149	142	139	138
H	102	102	106	114	127	146	166	171	161	150	142	139	138
I	95	98	104	114	127	146	165	169	159	150	145	139	135
J	71	75	82	101	123	146	163	167	158	151	138	124	122
I	108	111	121	141	173	192	195	198	190	166	137	123	120
L	127	131	144	170	193	198	198	201	196	165	137	124	121
M	—	105	157	173	181	184	185	190	193	167	140	125	—
N	—	—	120	162	171	181	182	189	186	140	125	—	—

b) POLAR COORDINATES OF HORIZONTAL HALF-SECTIONS OF TORSO

FIG. 4 TORSO TEST MASS FOR DYNAMIC TESTING

5.3 Buckle Shake Test

5.3.1 *General*

Apply this test to each adjustment buckle and each fastening buckle.

5.3.2 *Adjustment Buckles*

5.3.2.1 Move the webbing through the buckle so that an unset portion of webbing can be tested. Thread the webbing through the buckle in the manner intended by the manufacturer. Mark the webbing in the buckle and the buckle frame so that the marks align.

5.3.2.2 Grasp the webbing on either side of the buckle and shake it quickly by alternatively moving the webbing towards the buckle then away from it for a total of 25 cycles.

5.3.2.3 Observe the alignment marks. Misalignment of the marks indicates webbing slippage. Measure and record any slippage.

5.3.3 *Fastening buckles*

5.3.3.1 Couple the parts of the buckle together in the manner intended by the manufacturer.

5.3.3.2 Grasp the webbing either side of the buckle and shake it quickly by alternatively moving the webbing towards the buckle and away for a total of 25 cycles.

5.3.3.3 Observe and record whether or not the buckle inadvertently uncouples.

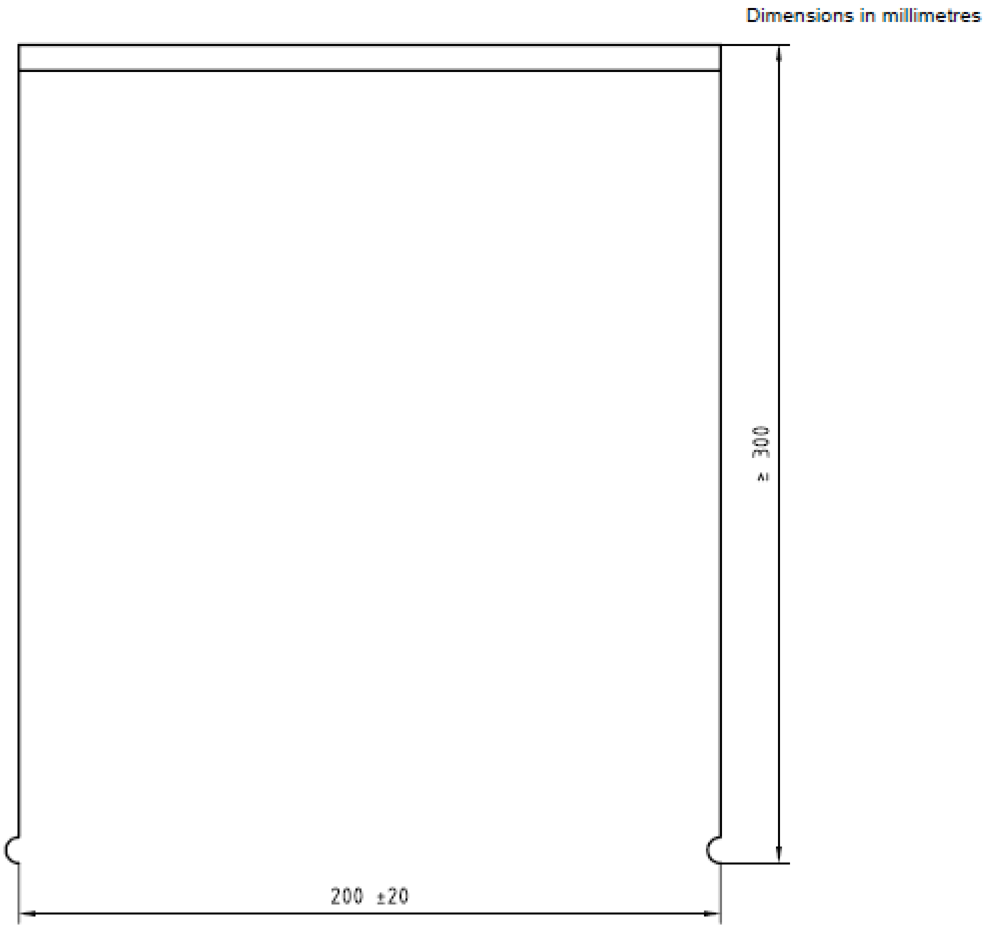


FIG. 5 TEST YOKE

5.4 Static Strength Test for Fall-arrest Attachment Elements

5.4.1 Fit the FBH to the torso test mass (**5.1.1**) in a similar manner to that when fitting to a person, in accordance with the manufacturer's instructions. Make all adjustments to ensure a snug fit of the FBH to the torso test mass.

5.4.2 Mark the webbing in each adjustment buckle and buckle frame so that the marks align.

5.4.3 Apply a tensile force of 15 kN between the fall-arrest attachment element and the lower eyebolt of the torso dummy, ensuring that the time to reach this force is (4 ± 1) min. Maintain this force for a period of 3 min.

5.4.4 Observe and record whether there is:

a) Any tearing of webbing material;
b) Any partial or complete separation of any sewn joint;
c) Any partial or complete fracture of any fastening or adjusting buckle;
d) Any inadvertent opening of any fastening buckle;
e) Any asymmetric migration of straps and attachment elements from original position; and
f) Any misalignment of buckle marks.

5.4.5 Repeat the test for all fall-arrest attachment elements. A new harness may be used in each case.

5.4.6 Repeat the procedures of **5.4.1** to **5.4.5** but by applying the test force between the fall-arrest attachment element and the upper eyebolt of the torso test mass.

5.5 Static Strength Test for Controlled-descent Attachment Elements

5.5.1 Fit the FBH to the torso test mass (**5.1.1**) in a similar manner to that when fitting to a person, in accordance with the manufacturer's instructions. Make all adjustments to ensure a snug fit of the FBH to the torso test mass.

5.5.2 Mark the webbing in each adjustment buckle and buckle frame so that the marks align.

5.5.3 Apply a tensile force of 15 kN between the controlled-descent attachment element and the lower eyebolt of the torso dummy, ensuring that the time to reach this force is (4 ± 1) min. Maintain this force for a period of 3 min. Measure and record in accordance with **5.4.4**.

5.6 Static Strength Test for Confined-space Access Attachment Elements

5.6.1 Fit the FBH to the torso test mass (**5.1.1**) in a similar manner to that when fitting to a person, in accordance with the manufacturer's instructions. Make all adjustments to ensure a snug fit of the FBH to the torso test mass.

5.6.2 Mark the webbing in each adjustment buckle and buckle frame so that the marks align.

5.6.3 Where necessary, attach the connectors of the test yoke ropes to the confined-space access attachment elements. Apply a tensile force of 15 kN between the test yoke and the lower eyebolt of the torso dummy, ensuring that the time to reach this force is (4 ± 1) min. Maintain this force for a period of 3 min. Measure and record in accordance with **5.4.4**.

5.7 Dynamic Performance Tests

5.7.1 *Feet First Test*

5.7.1.1 Fit the FBH to the torso test mass (**5.1.2**) in a similar manner to that when fitting to a person, in accordance with the manufacturer's instructions. Make all adjustments to ensure a snug fit of the FBH to the torso test mass. In addition, position the uppermost inner surface of the dorsal fall-arrest attachment element to lie (200 ± 20) mm below the flat end of the neck of the torso test mass.

5.7.1.2 Raise the torso test mass in an upright posture, and hold it in position by the quick-release device. Attach one end of the test lanyard to the fall-arrest attachment element under test using a connector complying with IS 3521(Part 5)/ISO 10333-5, and similarly the other end to the test-rig anchorage.

5.7.1.3 Raise the torso test mass so that:

a) The lifting eyebolt is at a maximum horizontal distance of 300 mm from the vertical axis of the test-rig anchorage before release; and
b) When the quick-release device is operated the torso test mass is allowed to fall freely over a distance of 1.0 m.

5.7.1.4 Release the torso test mass. Observe and record whether there is:

a) Any tearing of webbing material;
b) Any tearing of any primary strap sewn joint;
c) Any partial or complete fracture of any fastening or adjusting buckle; and
d) Any inadvertent opening of any fastening buckle.

5.7.1.5 Measure and record the angle formed between the back of the dummy and the test lanyard.

5.7.1.6 Leave the torso test mass in post-drop test suspension for a period of at least 10 min and observe that the torso test mass is retained.

5.7.1.7 Repeat the procedures **5.7.1.1** to **5.7.1.6** for each fall-arrest attachment element, using a new FBH and test lanyard in each case.

5.7.2 *"Head first test"*

5.7.2.1 Repeat the procedure in **5.7.1.1** using a new FBH.

5.7.2.2 Raise the torso test mass (**5.1.2**) in an inverted posture, and hold it in position by the quick-release device. Attach one end of a new test lanyard to the fall-arrest attachment point under test using a connector complying with IS 3521(Part 5)/ISO 10333-5, and similarly the other end to the test-rig anchorage.

5.7.2.3 Lower the torso test mass until the test lanyard is straight, without loading the FBH. Ensure that the attachment element under test is pointing upwards.

5.7.2.4 Raise the torso test mass so that:

a) The lifting eyebolt is at a maximum horizontal distance of 300 mm from the vertical axis of the test-rig anchorage before release;
b) When the quick-release device is operated the torso test mass is allowed to fall freely over a distance of 1.0 m.

At the end of the free fall the torso test mass will pivot about the fall-arrest attachment element. Therefore, a greater clearance will be required than that in the "feet first test".

5.7.2.5 Release the torso test mass. Observe and record in accordance with the procedures given in **5.7.1.4** to **5.7.1.6**.

5.7.2.6 Repeat the procedures **5.7.2.1** to **5.7.2.5** for each fall-arrest attachment point, using a new FBH and test lanyard in each case.

5.8 Static Suspension Test for Fall-arrest Attachment Elements

5.8.1 The test is to be carried out with a minimum of three people who are within the stature height range of 1.6 m to 1.9 m. Medical supervision shall be made available as a safety precaution during the tests in accordance with the Helsinki Declaration. If any person reports extreme pain during testing, the tests shall be stopped immediately.

NOTE — There is no set duration for each test since the purpose of the test is to detect obvious design defects only.

5.8.2 Attach the FBH to the first test participant in accordance with the manufacturer's instructions. Make all adjustments to ensure a snug fit.

5.8.3 Attach one end of the test lanyard to the fall-arrest attachment point using a connector complying with IS 3521(Part 5)/ISO 10333-5, and similarly the other end to an anchorage which is capable of supporting the test participant's mass with a safety factor of at least 10. This anchorage should be at a position so that the test participant can be freely suspended with the feet just clear of the test-rig floor. This can be achieved by raising the test participant with a winch. The clearance between the feet and floor shall not exceed 100 mm.

5.8.4 With the test participant clear of the test floor, observe and record whether there is:

a) Any metal fittings in contact with the groin, the inside of the thighs or the armpits;
b) Any part of the FBH exerting direct pressure on the genitals, head or neck;
c) Any intense pain felt; and
d) Any restriction to normal breathing.

5.8.5 Repeat the procedures described in **5.8.2** to **5.8.4** for each fall-arrest attachment point.

5.8.6 Repeat the procedures described in **5.8.2** to **5.8.5** for the remaining test participants.

5.9 Static suspension Angle Test for Class AE FBH

5.9.1 Fit the FBH to the torso test mass (**5.1.2**) in a similar manner to that when fitting to a person, in accordance with the manufacturer's instructions. Make all adjustments to ensure a snug fit of the FBH to the torso test mass.

5.9.2 Where necessary, attach the connectors of the test yoke ropes to the confined-space access attachment elements.

5.9.3 Raise the torso test mass so that it is just clear of the floor. Allow the torso test mass to remain suspended for 3 min, and then measure and record the angle between the back of the torso test mass and the test yoke ropes.

5.10 Flammability Resistance Test

5.10.1 *General*

5.10.1.1 This is a small-scale laboratory screening procedure for comparing the relative burning behaviour of vertically oriented plastic specimens exposed to a low energy level, ignition.

5.10.1.2 This method of test determines the after flame/afterglow times and damaged length of specimens. It is applicable to solid and cellular materials having an apparent density of not less than 250 kg/m^3. This method is not applicable for materials that spring away from the applied flame without igniting.

5.10.1.3 The classification system described is intended for quality assurance and the preselection of component materials for products. This system is not intended to assess the fire behaviour of building materials, furnishings, complete items of equipment or finished parts.

5.10.2 *Outline of the Method*

A test specimen bar is supported vertically by one end and the free end is exposed to a specified gas flame. The burning behaviour of the bar is assessed by measuring the after flame/ afterglow times.

5.10.3 *Significance of the Test*

5.10.3.1 Test made on a material under the conditions specified may be of considerable value in comparing the relative burning behaviour of different materials, in controlling manufacturing processes or in assessing any change in burning characteristics prior to, or during use. The results obtained from this method are dependent upon the shape, orientation and environment surrounding the specimen and the conditions of ignition. Correlation with performance under actual service condition is not implied.

5.10.3.2 Results obtained in accordance with this method shall not be used to describe or appraise the fire hazard presented by a particular material or shape under actual fire conditions, unless used as one element of a fire risk assessment that takes into account all of the factors that are pertinent to the assessment of the fire hazard in a particular end use for the material. Assessment for fire hazard requires consideration of such factors as fuel contribution, intensity of burning (rate of heat release) products of combustion and environmental factors, such as the intensity of source, orientation of exposed material and ventilation conditions.

5.10.3.3 Burning behaviour as measured by this test method, is affected by such factors as density, any anisotropy of the material and the thickness of the specimen.

5.10.3.4 Certain materials may shrink from the applied flame without igniting. In this event test results are not valid and additional test specimens are required to obtain ten valid tests. If the test specimens continue to shrink from the applied flame without igniting, these materials are not suitable for evaluation by this method of test.

5.10.3.5 The burning behaviour of some plastic materials may change with time. It is accordingly advisable to make tests before and after ageing by an appropriate procedure. The preferred ageing conditions shall be 7 days at 70 °C. However, other ageing times and temperatures may be used by agreement between the purchaser and the supplier and shall be noted in the test report.

5.10.4 *Apparatus*

5.10.4.1 Laboratory fume hood (cupboard) — Having an inside volume of at least 0.5 m^3 shall be used when testing the specimen. The chamber shall permit observation and shall be draught-free while permitting normal thermal circulation of air past the specimen during burning. For safety and convenience, it is desirable that this enclosure (which may be completely closed) be fitted with an evacuation device, such as an exhaust fan to remove products of combustion which may be toxic. However, it is important to note that the device shall be turned off during the actual test and started again immediately after the test to remove the products of combustion.

NOTE — The amount of oxygen available in support combustion is naturally important for the conduct of these flame tests. For tests conducted by this method when burning times are protracted chamber sizes less than 1 m3 may not provide accurate results.

5.10.4.2 *Laboratory burner* — A Bunsen burner having a tube length of 80 to 100 mm and an inside diameter of mm. The tube shall not be equipped with an end-attachment, such as a stabilizer.

5.10.4.3 *Ring stand with clamps or the equivalent* — Adjustable for positioning of the specimen.

5.10.4.4 *Timing device* — Accurate to 1 s.

5.10.4.5 *Measuring scale* — Graduated, in mm.

5.10.4.6 *Supply of technical grade methane gas* — With regulator and meter for uniform gas flow. Other gas mixtures having a heat content of approximately 37 MJ/m3 have been found to provide similar results.

5.10.4.7 *Desiccator* — Containing anhydrous calcium chloride or other drying agent.

5.10.4.8 *Conditioning Room or Chamber* — Capable of being maintained at 27 ± 2 °C and a relative humidity of 65 ± 5 percent.

5.10.4.9 *Complementary apparatus* (*see* Fig. 6).

5.10.4.10 *Dry absorbent surgical cotton*

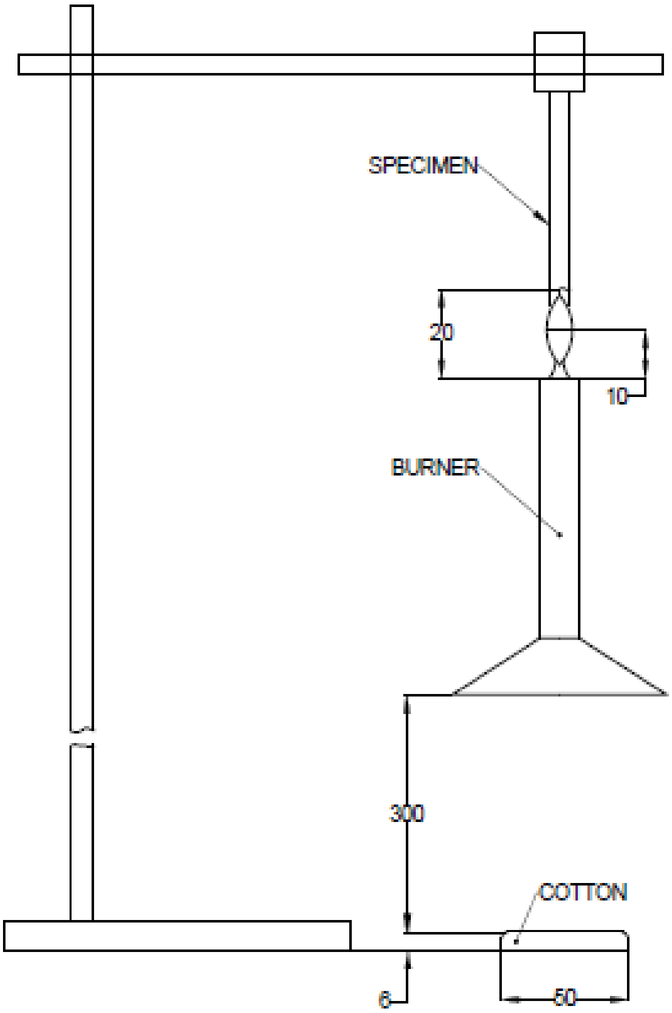


FIG. 6 VERTICAL BURNING BEHAVIOUR TEST APPARATUS

5.10.4.11 *Full-draught air-circulating oven* — Minimum of 25 air changes/hour, capable of being maintained at 70 ± 1 °C or other agreed temperature.

5.10.5 *Specimens*

5.10.5.1 All specimens shall be cut from a representative sample of the material (sheets or from end products), or shall be cast or injection, compression or transfer moulded to the necessary form. After any cutting operation, care shall be taken to remove all dust and any particles from the surface, cut edges shall have a smooth finish.

5.10.5.2 Standard bar specimen shall be 125 ± 5 mm long, 13.0 ± 0.3 mm wide and 3.0 ± 0.2 mm thick. Other thickness may be used by agreement between the purchaser and the supplier and, if so shall be noted in the test report.

NOTE — Tests made on specimens of different thicknesses or density are not comparable and tests made in different directions of anisotropy may also not be comparable.

5.10.5.3 A minimum of 26 bar specimens shall be prepared. It is advisable to prepare additional specimens in the event that the situation described in **5.10.3.4** is encountered.

5.10.6 *Conditioning*

5.10.6.1 Unless otherwise required by the material specification, the following shall apply.

5.10.6.1.1 Two sets of 5 bar specimens shall be preconditioned for at least 48 h at 27 ± 2 °C and 65 ± 5 percent relative humidity.

5.10.6.1.2 Two sets of 5 bar specimens shall be preconditioned for 168 h at 70 ± 1 °C and then cooled in a desiccator (**5.10.4.7**) for at least 4 h at ambient temperature.

5.10.6.1.3 All specimens shall be tested in a standard laboratory atmosphere of 27 ± 2 °C and 65 ± 5 percent relative humidity.

5.10.7 *Procedure*

5.10.7.1 Clamp the specimen from the upper 6 mm of its length with the longitudinal axis vertical so that the lower end of the specimen is 300 mm above a horizontal layer of dry absorbent surgical cotton (50 mm × 50 mm) thinned to a maximum uncompressed thickness of 6 mm (*see* Fig. 6).

5.10.7.2 Adjust the burner to produce a blue flame 20 ± 1 mm high. The flame shall be obtained by adjusting the supplying and air ports of the burner until an approximate 20 mm yellow-tipped blue flame is produced. Increase the air supply until the yellow tip disappears. Measure the height of the flame again and adjust it if necessary.

5.10.7.3 Place the flame of the burner centrally under the specimen, so that the top of the burner is 10 mm below the lower end of the specimen, and allow it to remain there for 10 s. Withdraw the burner to a distance at least 150 mm away and simultaneously start the timing device. Note the after flame time t, in seconds. If the specimen drips molten or flaming material during flame application, the burner may be tilted to an angle of 45° to avoid material dripping into the tube of the burner. However, the 10 mm distance shall be maintained between the major portion of the specimen and the tilted burner.

5.10.7.4 When after flaming of the specimen ceases, immediately place the flame of burner again under the specimen. After 10 s turn off the burner and note the after flame t_2 and afterglow t_3, times of the specimen.

5.10.7.4 The test procedure shall be conducted on at least five specimens.

5.10.8 *Expression of Results*

5.10.8.1 Calculate the total after flame time tfi, in seconds, for an individual specimen, using the formula:

$$t_{fi} = t_1 + t_2$$

where

t_1 = first afterflame time, in seconds;
t_2 = second afterflame time, in seconds; and
i = specimen number.

5.10.8.2 For each set of five specimens from a given preconditioning treatment, calculate the total set afterflame time tfs, in seconds, using the formula:

$$\sum_{i=1}^{5} t_{fi}$$

where i and ti are as defined in **5.10.8.1**.

5.10.8.3 Calculate the combustion time tci in seconds, for an individual specimen, using the formula:

$$t_{ci} = t_2 + t_3$$

where

i and t_2 are as defined in **5.10.8.1**; and t_3 = after glow time, in seconds.

5.10.9 *Categories of Burning Behaviour*

The behaviour of the specimens shall be classified in one of the categories given in Table 1 (FV = Flaming vertical specimen) determined by selecting the appropriate column, using test results to answer the conditional questions posed.

Table 1 Categories of Burning Behaviour

(*Clause* 5.10.9)

SlNo.	Conditions	Category (*see* Note 1)			
(1)	(2)	(3)	(4)	(5)	(6)
i)	If: Any individual specimen total after flame t_{fs}	≤ 10 s	≤ 30 s	≤ 30 s	> 30 s
ii)	And: Total set after flame time t_{fs}	≤ 50 s	≤ 250 s	≤ 250 s	> 250 s
iii)	And: Any individual specimen combustion time after the second flame application t_{ci}	≤ 30 s	≤ 60 s	≤ 60 s	> 60 s
iv)	And: After flame or after glowing up to the specimen holding clamp	No	No	No	Yes
v)	And: Cotton indicator ignited by flaming particles or drop	No	No	Yes	Yes or No
vi)	Then: The category is	FV-0	FV-1	FV-2	(*see* Note 2)

NOTES

1 If only one specimen from a set of five specimens for a given preconditioning treatment does not comply with the requirements for a category, another set of five specimens subjected to the same preconditioning shall be tested. All specimens from the second set shall comply with the appropriate requirements for the category.

2 The material may not be categorized by this method.

5.10.10 *Test Report*

The test report shall include the following particulars:

a) Complete identification of the product tested, including the manufacturer's name, number or code;
b) The thickness to the nearest mm, of the test specimen;
c) The direction of any anisotropy relative to the test specimen dimensions;
d) Conditioning treatment;
e) Any prior treatment before testing, other than cutting, trimming and conditioning; and
f) Classification according to the category code designation specified in **5.10.9**.

6 INSTRUCTIONS FOR GENERAL USE, MARKING, PACKAGING AND MAINTENANCE

6.1 Instructions for General Use and Maintenance

Clear instructions in English and Hindi, for fitting, adjustment and use shall be supplied with each FBH. Such instructions shall also include the following information:

a) The name of the manufacturer;
b) Where appropriate, the name and address of the supplier or such other information as enables the supplier to be traced;
c) A statement of the purposes and limitations of the FBH. Also that it should only be issued for use, when it is known that it will be part of a PFAS which will ensure that should an arrest take place, the arrest force will not exceed 6 kN and the arrest distance will be controlled;
d) A warning against making any alterations or additions to the product;
e) In cases where securing buckles (i.e. buckles other than those used primarily for adjustment of fit) are capable of assembly in more than one way, instructions of the method of assembly by which the harness complies with this part of IS 3521 and a warning against the use of any other methods of assembly;
f) A warning against the danger that may arise by the use of combinations of components and/or sub-system in which the safe function of any one component and/or sub-system is affected by, or interferes with, the safe function of another;
g) An instruction to make a visual inspection of the equipment immediately before use and to ensure that the equipment is in a serviceable condition and operates correctly;
h) Advice or limitations of the materials in the product which may affect its performance, for example temperature, the effect of sharp edges, chemical reagents, cutting, abrasion, UV degradation and that the user should consult the manufacturer in case of doubt;
j) Storage instructions;
k) Instructions for cleaning and/or washing;
m) Instructions for maintenance;
n) Advice that the equipment is to be inspected periodically, taking account of the conditions of use, and at least once a year, by a competent person according to the manufacturer's instructions;
p) A warning that repairs to the equipment be carried out only by the manufacturer or by a competent person appropriately authorized by the manufacturer;

q) Guidance concerning the inspection of the equipment and those factors (for example, fall indicator indication) that should cause the equipment to be discarded;

r) An instruction that any equipment that has been used to arrest a fall be removed from service;

s) An instruction that any work-positioning attachment elements mounted at the side waist positions shall not be used for connecting into a PFAS; and

t) Advice that before and during use, consideration should be given as to how any rescue of a user in post fall-arrest suspension can be safely and efficiently carried out.

6.2 Marking

FBH shall be clearly and indelibly marked or permanently labelled by any suitable method not having a harmful effect on materials with the following information:

a) The number of this part of IS 3521 [that is, IS 3521 (Part 1)], its type, and its class (for example, A, AD, ADP, ALP, etc.);

b) The name, trade mark or other means of identification of the manufacturer or the supplier who is responsible for acting on behalf of the manufacturer of the product for claiming compliance with this part of IS 3521 [that is, IS 3521 (Part 1)];

c) The manufacturer's product identification information that shall include the manufacturer's batch or serial number that enables the origin of the item to be traced;

d) The year of manufacture of the product;

e) The identity of the fibre used as the material of construction;

f) A fall indicator identification;

g) All information stating by appropriate means the intended purpose of each attachment element and specifically identifying those attachment elements that are designed to be used as part of a complete fall-arrest system (*see* **4.2**);

h) A warning to read the manufacturer's instructions; and

j) A special marking indicating the attachment point for a fall-arresting application. The letter "A", at least 3 cm in length and width and the width of each character stroke at least 0.5 cm, shall be marked on each shoulder strap below the back-mounted attachment element above the waist (Fig. 7). An arrow "↑" at least 5 cm in length and 3 cm in width and at least a 1 cm wide character stroke shall be marked on each shoulder strap immediately above or adjacent to the letter "A", pointing in the direction of the attachment element (*see* Fig. 6). All lettering shall be in a prominent contrasting colour.

6.3 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

6.4 Packaging

Each harness shall be supplied wrapped but not necessarily sealed in moisture-proof material.

7 SAMPLING

7.1 Lot

All the units of product, from those submitted for inspection at one time, produced under reasonably similar conditions of manufacture including time material and process shall be grouped together to constitute a lot.

Samples shall be selected at random from each lot separately and tested in order to ascertain conformity to the requirements of this specification.

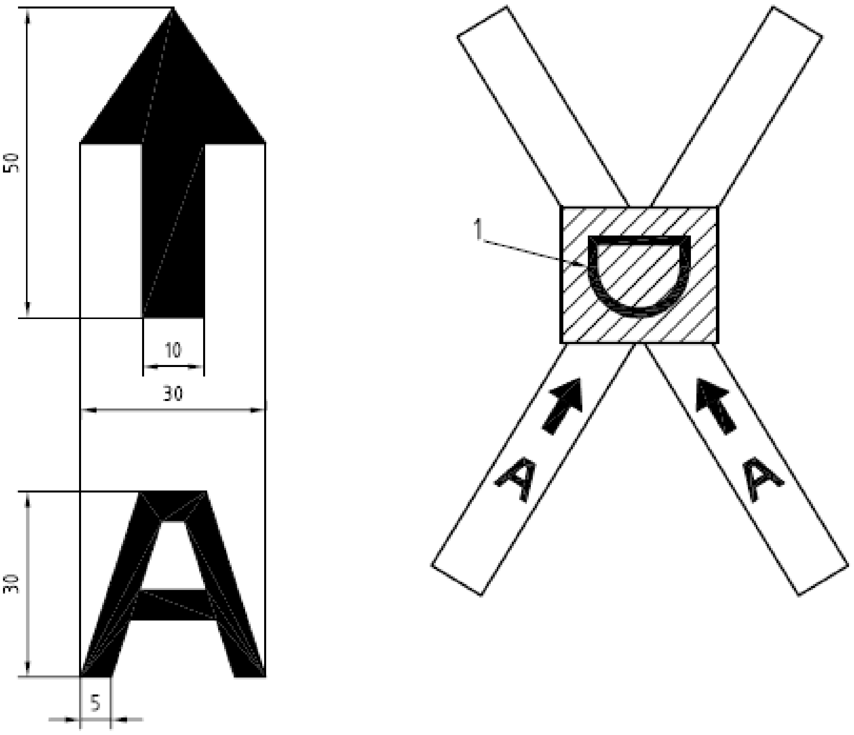
In order to ensure randomness of selection, use shall be made of random number tables. In case such a table is not available, the following procedure shall be adopted:

Starting from any unit, count them in one order as 1, 2, 3…,etc. up to r and so on, where r is the integral part of N/n (N being the total number in the lot and n being the number selected for the test). Every rth unit thus counted shall be withdrawn to constitute the sample (*see* IS 4905).

7.2 Sampling of Raw Materials and Components

7.2.1 To build reliable performance into the final assemblies of safety belt and straps, reliability of the component parts shall be ensured during production by reducing the quality fluctuations to the minimum through applications of statistical quality control methods [*see* IS 397 (Part 1)]. When adequate production control is maintained by the manufacturer, the past record of test results on components will be readily available to the purchaser for scrutiny and for the purpose of final inspection only small samples need be tested by him. Therefore, it is recommended that the manufacturer may carry out tests and maintain records of test results on the raw materials and components parts according to the procedures given in **7.2.2** and **7.2.3** respectively.

Dimensions in millimetres



a) Lettering

b) Location

Key

1 Fall-arrest attachment D-ring

Fig. 7 Special Marking for the Fall-Arrest Attachment Element

7.2.2 Whenever the Indian Standard specification exists for raw materials used in the manufacture may either obtain certificates from the supplier certifying conformance of the raw materials to the relevant specifications or he may test for conformance the raw materials according to test procedure specified in those Indian Standard specifications and maintain records of tests.

7.2.3 In conformance of the components, as given in this specification the manufacturer may conduct tests for ascertaining conformance to the specified requirements according to Table 2 if the tests are not destructive and according to Table 3 if the tests are destructive. The samples for test shall be selected at random. The lot shall be considered satisfactory if all the samples satisfy the requirements of this specification.

Table 2 Sample Size of Component Parts for Destructive Tests

(*Clause* 7.2.3)

No. of Units in the Lot (1)	No. of Units in the Sample (2)
Upto 25	5
26 to 150	8
151 to 1000	13
1001 and above	20

Table 3 Sample Size of Component Parts for Non-destructive Tests

(*Clause* 7.2.3)

No. of Units in the Lot (1)	No. of Units in the Sample (2)
Upto 25	1
26 to 100	2
101 to 500	3
501 and above	5

7.3 Scale of Sampling of Assembled FBH

7.3.1 For the purpose of performance test the assembled safety belts and straps shall be selected at random and shall be in accordance with col 2 of Table 4.

All the assemblies selected in **7.3.1** shall be subjected to performance test.

Table 4 Sample Size of Assembled FBH for Performance Test

(*Clause* 7.3.1)

No. of Units in the Lot (1)	No. of Units in the Sample (2)
Upto 25	1
26 to 100	2
101 to 500	4
501 and above	5

BIBLIOGRAPHY

[1] IS 4905, Random sampling and randomization procedures (*First Revision*)

[2] IS 397 (Part 1), Method for statistical quality control during production: Part 1 Control charts for variables (*Second Revision*)

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Occupational Safety and Health, CHD 08

Organization	*Representative(s)*
Director General, National Safety Council	Dr Lalit Gabhane (***Chairman***)
3 M India Ltd, Bangalore	Shri Vinay Pathak Shri Rishi Raj Arya (*Alternate*)
Atomic Energy Regulatory Board, Mumbai	Shri Lakshmi Nyaya Valiveti Shri Diptendu Das (*Alternate*)
Bhabha Atomic Research Centre, Mumbai	Shri S. D. Bharambe Shri G. Nagaraju (*Alternate*)
Builders Association of India, Mumbai	Nomination Awaited
Cement Manufacturers Association, New Delhi	Shri Sanjay Jain Shri Naveen K Sharma (*Alternate*)
Central Institute of Mining and Fuel Research (CIMFR), Dhanbad	Dr J. K. Pandey
Central Leather Research Institute, Chennai	Dr. M. Suriyanarayanan
Centre for Fire, Explosives & Environment Safety, Min of Def, New Delhi	Dr (Mrs) Arti Bhatt Dr S. Mary Celin (*Alternate*)
Coal India Limited, Kolkata	Shri Anil Kumar Bharali Shri Vinay Sehgal (*Alternate*)
Confederation of Indian Industries, New Delhi	Shri Shikhar Jain Shri Rakesh Tripathi (*Alternate*)
Defence Research and Development Organization, Ministry of Defence, New Delhi	Shri Nandula Suryanarayanan Shri K. G. Kapoor (*Alternate*)
Deptt of Industrial Policy and Promotion, New Delhi	Shri T. S. G. Narayannen Shri Nand Lal (*Alternate*)
Department of Space (ISRO), Bangalore	Shri T. Subbanathan Shri R. Manoj (*Alternate*)
Directorate General of Quality Assurance (DGQA), New Delhi	Dr R. K. Upadhyay Dr A. Yadav (*Alternate*)
Directorate General of Mines Safety (DGMS), Dhanbad	Shri Prabhat Kumar Shri K. Gyaneswar (*Alternate*)
Directorate General Factory Advice Service & Labour Institute, Mumbai	Shri Sumit Roy Shri H. M. Bhandari (*Alternate*)
Directorate General of Health Services (DGHS), New Delhi	Dr A. K. Mandal Dr A. N. Sinha (*Alternate*)
Directorate of Industrial Safety and Health (DISH), Gujrat	Shri Vilas Sudhakar Moray Shri A. K. Dongre (*Alternate*)
Directorate of Standardization, Ministry of Defence, New Delhi	The Secretary The Joint Director (Standards) (*Alternate*)
Directorate of Industrial Safety and Health, Maharashtra	Nomination Awaited
Directorate of Industrial Safety and Health, Tamil Nadu	Nomination Awaited

Organization	*Representative(s)*
Drager Safety India Pvt Ltd, Mumbai	Shri Hirendar Chaterjee Ms Jhankhana Gyani (*Alternate*)
Employee State Insurance Corporation, New Delhi	Dr Deepak Kumar Sharma Dr Ravindra Pawar (*Alternate*)
Hindustan Zinc Ltd, Ajmer	Shri Aniket Singh
Indian Chemical Council, Mumbai	Dr N. J. Singh Shri A. A. Panjwani (*Alternate*)
Indian Institute of Toxicology Research, Lucknow	Dr D. K. Patel Dr Sheelendra Pratap Singh (*Alternate*)
Indian School of Mines, (ISM), Dhanbad	Prof D. C. Panigrahi
Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam	Dr K. Satpathy
Intech Safety Pvt Ltd, Kolkata	Shri Subrata Mukherjee Shri Goutam Banerjee (*Alternate*)
Joseph Leslie Dynamiks Mfg Pvt Ltd, Mumbai	Shri Cyril Pereira Shri Dean Leslie Roy (*Alternate*)
Joseph Leslie and Co LLP, Mumbai	Nomination Awaited
Karam Industries, Noida	Shri Rajesh Nigam Shri Mohammad (*Alternate*)
Larsen & Turbo Ltd, Mumbai	Nomination Awaited
Ministry of Home Affairs, GoI, New Delhi	Shri D. K. Shami Dy Fire Advisor (*Alternate*)
Ministry of Labour, New Delhi	Nomination Awaited
National Disaster Management Authority, New Delhi	Shri Vijay Singh Nemiwal Shri Kunal Sharma (*Alternate*)
National Institute of Occupational Health, Ahmedabad	Dr B. Ravichandran Dr A. K. Mukherjee (*Alternate*)
National Institute of Disaster Management, New Delhi	Nomination Awaited
National Disaster Response Force, New Delhi	Nomination Awaited
National Safety Council, Navi Mumbai	Deputy Director General Shri A Y Sundkar (*Alternate*)
Northern India Textile Research Association, NITRA, Ghaziabad	Nomination Awaited
Nuclear Power Corporation of India Ltd, Mumbai	Shri Alok Varshney Shri M. U. Vincy (*Alternate*)
Oil Industry Safety Directorate (OISD), Min of Petroleum & Natural Gas, Mumbai	Shri Shashi Vardhan
Petroleum & Explosives Safety Organization, Nagpur	Shri M. K. Jhala Dr Yogesh Khare, (*Alternate*)
Quality Council of India, New Delhi	Shri A. K. Bahl Shri Abhay Pathak (*Alternate*)
M/s Reflectosafe, Mumbai	Shri Lalit B. Aggarwal Shri Balram Chadha (*Alternate*)

Organization	*Representative(s)*
Reliance Industries Limited, Mumbai	Dr Prasad Tipnis Shri Neeraj Sharma (*Alternate*)
Research, Design and Standard Organization, New Delhi	Nomination Awaited
Safety Appliances Manufacturers Association, Mumbai	Shri M. Kant Shri Kirit Maru (*Alternate*)
Steel Authority of India Ltd, Ranchi	Shri Kalidas Sen Gupta Shri Shashi Vasistha (*Alternate*)
The Singareni Colleries Company Limited, Kothagudem	Nomination Awaited
Unicare Emergency Equipment Pvt Ltd, Mumbai	Nomination Awaited
Venus Safety and Health Pvt Ltd, Navi Mumbai	Shri Mahesh Kudav Shri Ravi Shinde (*Alternate*)
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Member Secretary

Ms. Preeti Prabha
Scientist 'C' (CHD), BIS

(*Continued from second cover*)

The composition of the committee responsible for formulation of this standard is given at Annex-A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*).’ The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Amendments Issued Since Publication

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